2-Dimensional Image Data Analysis of Color Dynamics in Electrochromic Display Devices

([1]*Graduate School of Information Science and Technology*, *Osaka University*, [2]*National Institute for Materials Science,* [3]*Wakayama University*) ○Shifa Sarkar,[1,2] Takefumi Yoshida,[3] Masayoshi Higuchi[1,2]

Keywords: Electrochromic Devices; Image Data Analysis; Metallosupramolecular Polymer

Electrochromic devices (ECDs) represent advanced innovations that employ voltage-responsive materials capable of altering color, making them ideal for diverse applications like display devices, smart windows, and energy-saving systems.[1] Among electrochromic (EC) materials, metallo-supramolecular polymers (MSPs) have gained significant interest because of their inherent structural versatility and adjustable optical properties.[2] However, a major challenge lies in the analytical methods used to examine their EC characteristics. Traditional methods, which typically depend on spectrophotometric techniques, often lack sufficient spatial resolution and are incapable of capturing the complete dynamic range of EC transitions.[3]

We report a two-dimensional (2D) image-based analytical approach that combines high-resolution imaging with quantitative analysis to overcome these shortcomings. A solid-state polyFe-based ECD was fabricated using a spray coating method. A non-uniform color change from purple to colorless was observed in the ECD. A movie of the EC changes was taken during the cyclic operation at 1.2 V. Images were extracted from the movie then converted to grayscale images, from where pixel values were extracted using Python OpenCV. Finally, a contrast versus time graph was generated using the pixel values to analyze the EC transition pattern across the entire device (Fig. 1). This analysis revealed that the reaction time in the device became slower in the central region compared to the edge regions due to the variations in localized resistances within the ITO electrodes.

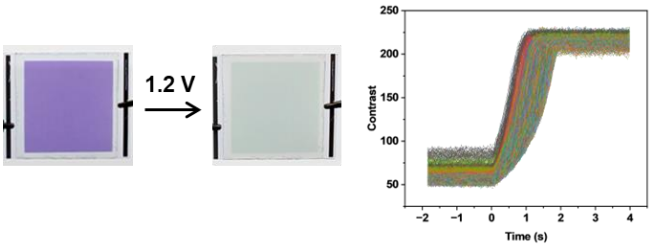

Fig. 1: Color-changing pattern of polyFe-based ECD.

ACKNOWLEDGMENT: this research was supported by the Mirai project (JPMJMI21I4) from the Japan Science and Technology Agency (JST) and the Environment Research and Technology Development Fund (JPMEERF20221M02) from Environmental Restoration and Conservation Agency (ERCA).

1) Higuchi, M.; J. Mater. Chem. C **2014**, *2*, 9341. 2) Gustavsen, A.; Sol. Energy Mater. Sol. Cells, **2010**, *94*, 105. 3) Higuchi, M.; Sol. Energy Mater. Sol. Cells, **2019**, *200*, 110000.